



## HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF GROWING *BALAMI* RAMS FED FOUR VARIETIES OF HYDROPONIC SORGHUM FODDER WITH SUPPLEMENTS

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### ABSTRACT

The study evaluated the effects of four varieties of hydroponic sorghum fodder with supplements on haematological and serum biochemical indices of growing *Balami* rams. Twenty growing *Balami* rams with an average body weight of 20±1kg were randomly allocated to four treatment groups, each receiving a different variety of hydroponic sorghum fodder (*Red Chakalari*, *White Chakalari*, *Kaura and Jigari* varieties as V1, V2, V3 and V4 respectively) with supplements. Blood samples were collected after a 70-day feeding trial to determine the effects of the diets on haematological parameters (packed cell volume, haemoglobin, red blood cell count, white blood cell count, erythrocytic indices) and serum biochemical indices (glucose, total protein, albumin, urea, creatinine etc). The results showed no significant variations ( $P>0.05$ ) in some haematological parameters before morning feeding but they differed significantly ( $P<0.05$ ) four hours after feeding. The serum biochemical parameters among the treatment groups were significantly ( $P<0.05$ ) different at four hours after feeding in all the parameters except blood glucose and serum glutamic pyruvic transaminase. Thus, most of the values obtained before morning feeding were not ( $P>0.05$ ) statistically varied among the groups. However, all haematological and biochemical parameters fell within normal ranges for sheep, indicating that the hydroponic sorghum fodder varieties with supplements were not detrimental to the health of growing *Balami* rams. The study suggests that hydroponic sorghum fodder can be a viable feed option for sheep, however further research is needed to optimize its nutritional benefits.

**Keywords:** Haematology, Hydroponic, Sorghum, Fodder, *Balami* Rams.

### INTRODUCTION

Haematological and serum biochemical values have been considered useful for the evaluation of body condition, nutritional and immune status in animal where other tissue related measurements are not available (Anurudu and Ewuola, 2010). The significance of determining haematological and biochemical indices of domestic animals have been well documented Anurudu and Ewuola, (2010) and changes of these parameters have been studied in cattle (Oduguwa *et al.*, 2007), sheep (Sowande *et al.*, 2008; Fajemisin *et al.*, 2010) and goat (Anurudu and Ewuola 2010). When blood is examined, it provides a good opportunity to clinically investigate the presence of several metabolites and other constituents in the body of an animal. This is in line with the recommendation of Jain (1993) on the use of blood biochemical values in medical nutritional assessment. Blood examination is also a good way of assessing the health status of an animal as it plays a vital role in the physiological, nutritional and pathological status of an animal/organism. Haematological and serum biochemical parameters are good indices of the physiological status of animals and changes in the values of these parameters can be used to assess the response of animals to various physiological situations (Esonu *et al.*, 2006). Jain (1993) reported that the importance of investigating blood composition is to have a way of distinguishing normal status from state of stress. Such stress factor can be nutritional, environmental or physical; thus, this study was designed to evaluate the haematological and serum biochemical indices of *Balami* rams fed four varieties of hydroponic sorghum fodder with concentrate supplements.



## MATERIALS AND METHODS

### Study Area

The experiment was carried out at the Livestock Teaching and Research Farm University of Maiduguri, Borno State. Maiduguri is situated at latitude 11° 51'N and longitude 13° 09'E at an altitude of 354 m above sea level (Encarta, 2007), which falls within the semi-arid zone of West Africa. The area is characterized by short period of rainy season (3-4 months) June to September with annual rainfall ranging from 500 to 600 mm (Biu *et al.*, 2012). Long period of dry season (8-9 months) October to May were also observed annually. Ambient temperatures are high (38-44°C) in the months of March to May whereas low temperatures were recorded in December and January ranging from 15-19°C (Weather and climate, 2016). Relative humidity is low in the month of March (30%) and high in the month of August (80%) according to Biu *et al.* (2012).

### Experimental Diets

Four varieties of sorghum seeds (*Red Chakalari* (V1), *White Chakalari* (V2), *Kaura* (V3) and *Jigari* (V4)] were hydroponically grown and harvested at 8 days harvesting period served as basal diets. Supplement diet was formulated with a crude protein (CP) of 16% as presented in Table 1. The supplement diet was given at 300g per animal per day while the basal diets was given *ad libitum*.

**Table 1:** Ingredients and Percentage Composition of Supplement Diet for the Experiment

Ingredients (%)	Quantity (kg)
Maize bran	58.50
Cotton seed cake	39.00
Bone meal	02.00
Salt	00.50
Total	100.00

### Experimental Animals and Their Managements

Twenty (20) growing *Balami* rams with initial body weight of 20±1kg were used for the experiment. They were sourced from Maiduguri Livestock Market. The animals were quarantined for 3 weeks and observed for any health problem and all prophylactic treatment were given. The animals were fed with the experimental diets so as to adapt to it during the quarantine.

### Experimental Design and Diets

The animals were randomly assigned into four treatment groups consisting of five replicates per treatment in a Completely Randomized Design (CRD). The 8<sup>th</sup> day hydroponic sorghum fodder varieties were given as basal diets *ad libitum* to the respective groups as V1, V2, V3 and V4 while similar supplement diet was given at 300g per animal and the feeding trial lasted for 70 days.

### Blood Profile Analysis

During the last week of the feeding trial, blood samples were collected from all the animals before morning feeding and four (4) hours after morning feeding. The animals were restrained by holding their fore and rear legs on the ground in a standing position while the blood sample was collected from their jugular vein after disinfecting the point with 70% alcohol and zylene to dilate the veins. Sterile syringe and needle were used to puncture the veins and covered with sterile cotton wool after collection. Five millilitres (5mls) of blood were taken from each ram and divided into two equal portions for haematology and biochemical analysis.

### Haematological Indices

The first portion of the blood samples was transferred into sample bottles containing ethylene diamine tetra-acetic acid (EDTA) to serve as anti-coagulant and was properly mixed by gently turning round the bottle to prevent haemolysis of the blood cells. The samples were analyzed for Packed Cell Volume (PCV), Red Blood Cells (RBC), White Blood Cells (WBC) and Haemoglobin (Hb) concentration. The erythrocytic indices such as mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were computed according to Jain (1993) as shown below:



$$\text{MCV} = \frac{\text{PCV} (\%) \times 10}{\text{RBC Count} (10^6/\text{mm}^3)}$$

$$\text{MCH} = \frac{\text{Hb} (\text{g/dl}) \times 10}{\text{RBC Count} (10^6/\text{mm}^3)}$$

$$\text{MCHC} = \frac{\text{Hb} (\text{g/dl}) \times 100}{\text{PCV} (\%)}$$

### **Biochemical Analysis**

Second portion of the blood samples were collected at the same time with that of haematology and were kept in a plain bottle i.e. without anti-coagulant. The samples were subjected to biochemical analysis using routinely available clinical methods. The blood protein, albumin and urea were determined using sigma assay kit, glucose was analyzed by Jain's method while electrolytes were determined using conventional methods (AOAC, 2000).

### **Statistical Analysis**

Data collected were subjected to analysis of variance of a Completely Randomized Design (CRD) using General Linear Model of SAS (2000) and means were separated using Least Significant Difference (LSD).

## **RESULTS AND DISCUSSIONS**

### **Haematological Parameters of Growing Balami Rams Fed Four Varieties of Hydroponic Sorghum Fodder with Supplements**

The values of haematological parameters of the experimental animals fed four different varieties of HSF with supplements were shown in Table 2. Packed cell volume (PCV) was not significant ( $P > 0.05$ ) in treatment groups before feeding. They have a range of 27.5% (V3) to 29% (V1). However, significant ( $P < 0.05$ ) difference was observed in PCV values four hours after feeding, the values ranged from 25.5 (V3) to 28.5% (V4). Thus, it showed a decrease four hours after feeding. Mean haemoglobin (Hb), white blood cells (WBC) and red blood cells (RBC) were not significant ( $P > 0.05$ ) in experimental rams before feeding. Though, statistical ( $P < 0.05$ ) difference was observed in Hb, WBC and RBC four hours after feeding with the following ranged values 8.45g/dl (V3) to 9.5g/dl (V4),  $4.15 \times 10^3 \text{mm}^3$  (V2) to  $7.90 \times 10^3 \text{mm}^3$  (V4) and  $9.50 \times 10^6 \text{mm}^3$  (V1) to  $12.70 \times 10^6 \text{mm}^3$  (V3) respectively. The results for erythrocytic indices showed no significant ( $P > 0.05$ ) difference in mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) before feeding with a range value of 24.77 to 25.70fl and 8.2 to 8.56pg respectively. Significant ( $P < 0.05$ ) difference exists four hours after feeding in MCV, MCH and mean corpuscular haemoglobin concentration (MCHC).

**Table 2:** Haematological Parameters of Growing *Balami* Rams Fed Varieties of Hydroponic Sorghum Fodder with Supplements

Parameters		Treatments				SEM	LS	Ref Value
		V1	V2	V3	V4			
PCV (%)	BF	29.00	28.50	27.50	28.50	1.57	NS	24-50
	4hrs AF	28.00 <sup>a</sup>	28.50 <sup>a</sup>	25.50 <sup>b</sup>	28.50 <sup>a</sup>	1.27	*	
Hb (g/dl)	BF	9.65	9.50	9.10	9.45	0.52	NS	08-16
	4hrs AF	9.30 <sup>ab</sup>	9.45 <sup>a</sup>	8.45 <sup>b</sup>	9.50 <sup>a</sup>	0.43	*	
WBC ( $\times 10^3 \text{mm}^3$ )	BF	7.30	7.55	6.55	6.30	0.34	NS	04-12
	4hrs AF	5.90 <sup>b</sup>	4.15 <sup>c</sup>	7.40 <sup>a</sup>	7.90 <sup>a</sup>	0.40	*	
RBC ( $\times 10^6 \text{mm}^3$ )	BF	11.60	11.20	11.10	11.10	0.98	NS	08-16
	4hrs AF	9.50 <sup>c</sup>	10.80 <sup>bc</sup>	12.70 <sup>a</sup>	11.60 <sup>ab</sup>	0.60	*	
MCV (fl)	BF	25.00	25.45	24.77	25.67	1.20	NS	23-48
	4hrs AF	29.49 <sup>a</sup>	26.78 <sup>a</sup>	20.08 <sup>b</sup>	24.57 <sup>ab</sup>	2.18	*	
MCH (pg)	BF	8.32	8.48	8.19	8.51	0.40	NS	07-12
	4hrs AF	9.99 <sup>a</sup>	8.95 <sup>a</sup>	6.65 <sup>b</sup>	8.19 <sup>ab</sup>	0.73	*	
MCHC (%)	BF	33.28 <sup>a</sup>	33.33 <sup>a</sup>	33.09 <sup>b</sup>	33.16 <sup>b</sup>	0.04	*	31-38
	4hrs AF	33.21	33.16 <sup>b</sup>	33.14 <sup>b</sup>	33.33 <sup>a</sup>	0.06	*	

PCV = Packed Cell Volume, Hb = Haemoglobin, WBC = White Blood Cell, RBC = Red Blood Cell, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration, SEM = Standard Error of Mean, LS = Level of Significance, \* = ( $P < 0.05$ ), NS = Not Significant, <sup>a,b,c,d</sup> = Means in the same row with different superscripts are significantly different, Ref. Value = Reference Value, Ref. Value Source = Jain, (1993).

Blood is vital to life and before any meaningful activities to be done on biology of an animal, haematology study is important because any abnormal variation in haematology of cells affects the physiological function of the animal (Kolan *et al.*, 2012). Haematological constituents are always reflection of animals' responsiveness to their internal and external environment according to Isida Somen *et al.* (2011). The values of haematocrit indices (PCV, Hb, WBC, RBC) before feeding and four hours after feeding were within the normal range values for a healthy sheep reported by Jain (1993). The mean PCV values (25.50 to 29.00%) of this work compared favourably with range values (22.50 to 35.50%) for *Yankasa* rams fed treated sorghum stover supplemented with three varieties of lablab forages (Girgiri, 2017). Haemoglobin concentration is associated with greater ability to resist disease infection while animals with lower than normal Hb levels indicates low level of nutrition and possibly disease infection (Cheesbrough, 2004; Tambuwal *et al.*, 2002). The Hb values in the current study were in conformity with the range of 9.25 to 9.80g/dl obtained by Dangut (2016) who fed *Yankasa* rams using acha straw diets with energy:protein supplement.

The WBC are the chief function of importing immunity to the body (Okunade *et al.*, 2015), the decrease or increase in circulating WBC indicates physiological condition. Egbe-Nwiyi *et al.* (2000) and Addass *et al.* (2010) reported that WBC values of adult sheep are comparable to those of young lambs. They also indicate that higher or lower values of WBC could mean that the animals' immune system was compromised by infection or toxic substances. Normal WBC ranged values of 6.55 to 7.55  $\times 10^3 \text{mm}^3$  before feeding and 4.15 to 7.90  $\times 10^3 \text{mm}^3$  four hours after feeding recorded in the current study is an indication that the animals were in good health status. The observed WBC values in this study may be attributed to good intensive management of the experimental rams which took all necessary measures to curtail diseases.

The results for RBC in the present study ranged from 11.00 to 11.60  $\times 10^6 \text{mm}^3$  before feeding and 9.50 to 12.70  $\times 10^6 \text{mm}^3$  four hours after feeding. It is showing the total number of red blood cells in one micro litre of blood. High RBC counts may be associated with conditions that cause the body to produce too many red blood cells (Polycythemia) or impaired pulmonary function while low RBC counts may be associated with blood loss, inadequate RBC production in the bone marrow or actual



destruction of the RBC with the body, iron deficiency, internal bleeding, some types of anaemia or vitamin deficiency. Shakoori *et al.* (1992) suggested that decrease in RBC counts is either an indication of excessive damage to erythrocyte or inhibition of erythrocytes formation. Furthermore, Cheesebrough (2004) maintained that RBC count vary with age, gender geographical location and health status of the animals. The RBC counts obtained in the current study is higher than  $4.49$  to  $8.79 \times 10^6 \text{mm}^3$  for Yankasa rams fed treated sorghum stover supplemented with three varieties of lablab forage (Girgiri, 2017),  $7.58$  to  $9.94 \times 10^6 \text{mm}^3$  and  $6.40$  to  $10.47 \times 10^6 \text{mm}^3$  for local and improved sheep respectively but lower than  $14.70 \times 10^6 \text{mm}^3$  for *Awassi* ewe reported by Jawasreh *et al.* (2010). The RBC counts in this study were within the normal range of  $9.00$  to  $15.00 \times 10^6 \text{mm}^3$  for sheep in Merck Manual (2016). The variation in the RBC counts in this study with other studies might be attributed to feed, age, gender, geographical location, breeds and health status of the animals.

The erythrocytic indices (MCV, MCH and MCHC) were all within the normal recommended range values postulated by Jain, (1993). The MCV is confirmed to be linked to RBC and MCV greater than 100 femtolitres (fl) indicates macrocytosis (an enlargement of the RBC). The MCV recorded in the current study were statistically ( $P > 0.05$ ) not different before feeding with a ranged value of 24.77 to 25.70fl. However, significant ( $P < 0.05$ ) variation was observed four hours after feeding having a range value of 20.08 to 29.49fl which were within the normal ranged value of 23 to 48fl for a healthy sheep reported by (Plumb, 1999). The values obtained in the present study were higher than 16.20fl acquired by Okunade *et al.* (2015) for *Yankasa* rams, but lower than 42.70 to 43.80fl for *Yankasa* rams fed with treated sorghum stover supplemented with three varieties of lablab forage (Girgiri, 2017).

The MCH values for the current work was not statistically different ( $P > 0.05$ ) across the treatments before feeding but they varied four hours after feeding. Although all the values recorded were within the range of 7 to 12pg for a healthier animal (Jain, 1993). However, Jawasreh *et al.* (2010) reported a higher range value of 9.6 to 14.4pg for improved *Awassi* sheep, while Girgiri (2017) got a range of 13.10 to 17.20pg for *Yankasa* rams. Similarly, the MCH values (6.65 to 9.6pg) of the current study was in agreement with the range of 8 to 12pg of Merck manual (2016). MCHC is very significant in anaemia diagnosis and is an index of the capacity of bone marrow to produce RBC (Njidda *et al.*, 2014). The values reported in the current work were different across the groups at both before feeding and four hours after feeding with a similar value ranged from 33.15 to 33.33%. The values compared well with the normal range of 31 to 34% (Plumb, 1999) and 31 to 38% (Jain, 1996) and 31.95 to 32.50% (Girgiri, 2017) before feeding *Yankasa* rams fed treated sorghum stover with three lablab forage variety. However, present values were lower than 41.75 to 43.80% recorded by Girgiri (2017) after feeding the animals. It is indicated that MCHC, MCV and MCH are very significant in diagnosis of anaemia in ruminant animals. The results of this study shown that all the animals fed with HSF varieties were healthier and not anaemic.

### **Serum Biochemistry of Growing *Balami* Rams Fed Varieties of Hydroponic Sorghum Fodder with Supplements**

The result for serum biochemical parameters of growing *Balami* rams fed four varieties of HSF with supplements were presented in Table 3. Total protein, albumin, globulin and cholesterol values were significantly ( $P < 0.05$ ) different among the groups of rams fed varieties of HSF before feeding and four hours after feeding. Significant ( $P < 0.05$ ) variation was also observed four hours after feeding in values of urea, creatinine, total and conjugated bilirubins, serum glutamic oxaloacetic transaminase (SGOT or ASAT) and alkaline phosphatase hence, reverse (not significant) was the case before feeding. Glucose and serum glutamic pyruvic transaminase (SGPT or ALAT) have a ranged values of 2mmol/l to 3.2mmol/l and 1u/l to 18.5u/l respectively with statistica ( $P < 0.05$ ) difference between the treatment groups before feeding. But no significant ( $P > 0.05$ ) different were recorded four hours after feeding in glucose and ALAT values.

**Table 3:** Serum Biochemistry of Growing *Balami* Rams Fed Four Varieties of Hydroponic Sorghum Fodder with Supplements

Parameters		Treatments				SEM	LS	Ref Values
		V1	V2	V3	V4			
TB mmol/l	BF	2.00	1.80	1.55	1.45	0.47	NS	1.71 – 8.55
	4hrs AF	0.90 <sup>b</sup>	1.24 <sup>ab</sup>	1.80 <sup>a</sup>	1.60 <sup>a</sup>	0.22	*	
CB mmol/l	BF	3.55	4.55	3.60	3.30	3.30	NS	0 – 4.61
	4hrs AF	2.10 <sup>c</sup>	2.71 <sup>bc</sup>	3.65 <sup>ab</sup>	4.40 <sup>a</sup>	0.42	*	
TP g/l	BF	54.50	61.00 <sup>a</sup>	56.50 <sup>b</sup>	55.50 <sup>b</sup>	1.51	*	24 – 30
	4hrs AF	61.00 <sup>ab</sup>	60.00 <sup>ab</sup>	58.50 <sup>b</sup>	62.50 <sup>a</sup>	1.28	*	
ALB g/l	BF	32.00 <sup>a</sup>	36.50 <sup>a</sup>	28.50 <sup>b</sup>	31.00 <sup>b</sup>	2.33	*	24 – 30
	4hrs AF	30.00 <sup>b</sup>	31.75 <sup>b</sup>	26.50 <sup>b</sup>	37.00 <sup>a</sup>	2.19	*	
GLO g/dl	BF	22.50 <sup>b</sup>	24.50 <sup>ab</sup>	28.00 <sup>a</sup>	24.50 <sup>ab</sup>	2.19	*	
	4hrs AF	31.00 <sup>a</sup>	28.25 <sup>ab</sup>	32.00 <sup>a</sup>	25.50 <sup>b</sup>	1.85	*	
ASAT iu/l	BF	91.00	101.00	104.50	99.00	6.38	NS	60 – 280
	4hrs AF	109.00 <sup>a</sup>	100.13 <sup>a</sup>	103.50 <sup>a</sup>	52.00 <sup>b</sup>	17.58	*	
ALAT iu/l	BF	18.50 <sup>a</sup>	15.50 <sup>ab</sup>	15.50 <sup>ab</sup>	13.00 <sup>b</sup>	1.67	*	22 – 33
	4hrs AF	13.00	15.00	15.00	16.50	2.61	NS	
GLU mmol/l	BF	3.10 <sup>ab</sup>	2.00 <sup>c</sup>	3.20 <sup>a</sup>	2.90 <sup>b</sup>	0.09	*	1.7 – 3.6
	4hrs AF	3.50	3.90	4.05	3.90	0.24	NS	
CHOL mmol/l	BF	2.10 <sup>ab</sup>	2.25 <sup>a</sup>	1.95 <sup>b</sup>	2.00 <sup>b</sup>	0.10	*	1.05 – 1.50
	4hrs AF	1.70 <sup>ab</sup>	1.66 <sup>b</sup>	2.30 <sup>a</sup>	1.90 <sup>ab</sup>	0.56	*	
UREA/N mmol/l	BF	4.45	4.45	3.90	4.00	0.37	NS	3 – 10
	4hrs AF	3.90 <sup>c</sup>	5.45 <sup>b</sup>	5.45 <sup>ab</sup>	6.10 <sup>a</sup>	0.43	*	
CREAT mmol/l	BF	83.50	94.00	87.00	92.00	11.07	NS	70 -105
	4hrs AF	76.00 <sup>b</sup>	93.00 <sup>a</sup>	87.00 <sup>ab</sup>	93.00 <sup>a</sup>	7.19	*	
ALK iu/l	BF	84.00	95.00	56.50	77.50	17.31	NS	70 -390
	4hrs AF	106.00 <sup>a</sup>	104.50 <sup>a</sup>	30.50 <sup>c</sup>	52.00 <sup>b</sup>	3.57	*	

TB = Total Bilirubin, CB = Conjugated Bilirubin, TP = Total Protein, ALB = Albumin, GLO = Globulin, ASAT (SGOT) = Serum Glutamic Oxaloacetic Transaminase, ALAT (SGPT) = Serum Glutamic pyruvic Transaminase, GLU = Glucose, CHOL = Cholesterol, CREAT = Creatinine, ALK.PHOS = Alkaline Phosphatase, BF = Before Feeding, AF = After Feeding, Hrs = Hours, SEM = Standard Error of Mean, LS = Level of Significance, \* = (P<0.05), <sup>a,b,c</sup> = Means in the same row with different superscripts are significantly different, NS = Not Significant. Reference Values Source: Peter and Peter, (2002).

The serum biochemical analysis is used to determine the level of heart attack, liver damage, to evaluate protein quality and amino acid requirements in animals. Serum biochemistry also measures the number of enzymes, proteins, sugar, electrolytes, minerals, and hormones found in the liquid portion of the blood (Jain, 1993). The biochemical indices of *Balami* rams in this study were significantly (P<0.05) different at four hours after feeding in all the parameters except for blood glucose and serum glutamic pyruvic transaminase. However, the values obtained before feeding were not statistically different (P>0.05) among the groups for direct and conjugated bilirubins, serum glutamic oxaloacetic transaminase, urea, creatinine and alkaline phosphatase. Though total protein, albumin, cholesterol and globulin were significantly different in both before feeding and four hours after feeding across the treatments.

The values (3.90 to 6.10mmol/l) of urea obtained in the current study were within the reference value of 3.0 to 10mmol/l reported by Peter and Peter (2002) and 5.70 to 6.10mmol/l for *Balami* rams obtained by Njidda *et al.* (2014) but also reported a higher range value of 7.20 to 7.50mmol/l for *Ouda* sheep and 6.1 to 7.0mmol/l for *Yankasa* sheep in the study of haematological and serum biochemical indices of sheep in semi-arid environment of northern Nigeria. Amuda (2018) testified a range value of 23.63 to 47.27mg/dl for West African Dwarf sheep fed ensiled maize stover and concentrate supplements. Nonetheless, Girgiri, (2017) also observed a higher ranged values of 7.75 to 15.30mmol/l



for *Yankasa* rams fed treated sorghum stover with tree lablab varieties. Similarly, the values obtained in this study was in disparity with the values of 11.51 to 17.63mmol/l (Ngele *et al.*, 2009). The high level of serum urea has been attributed to excessive tissues protein catabolism associated with protein deficiency (Jain,1993). The urea value obtained was within the range of 8 to 20 mg/dl (Baneejee, 2007) in matured domestic animals and 5.28 mg/dl for free ranging desert big-horn sheep. When blood urea is higher than normal range it is symptom of kidney failure and when lower than normal is an indicative of decreased hepatic function. However, the values for urea nitrogen recorded in this study is factual and has no negative effects on the blood and health status of the rams, but differences observed with other references may due to breed differences, geographical local location and diet consumed.

The total protein values of 54.50 to 62.5g/l in this study were within the range of 60 to 64g/l recorded for *Balami* rams by Njidda *et al.* (2014) but also reported higher range values of 71 to 83g/l for *Ouda* rams and 69 to 73g/l for *Yankasa* rams in evaluating the haematological and serum biochemical indices of sheep in semi-arid environment of northern Nigeria. Ngele *et al.* (2009) observed a range of 68.63 to 73.76g/dl. However, the values for the current study were not in conformity with the reference range of 24 to 30g/l (Peter and Peter, 2002) and lower than the range of 9.4 to 14.26g/dl reported by Amuda (2018) for *Yankasa* rams, 6.3 to 7.2g/dl by Bello and Tsado (2013), and 5.0 to 12.3g/dl (Jawasreh *et al.*, 2010). Total protein increases due to dehydration, chronic inflammation and para-protein anaemia while its decrease is caused by over hydration, severe congestive heart failure and other conditions (Amuda, 2018). However, the results of this study showed no sign of any disease associated with protein. This implies that the animals were well managed and fed.

Creatinine values in this study were in the range of 76 to 95mmol/l which were within the recommended range of 70 to 103mmol/l (Peter and Peter, 2002). It was lower than the range of 98 to 139 for *Balami* sheep and 107 for *Ouda* ewe (Njidda *et al.*, 2014). However, the values of the current study were higher than 1.45 to 1.70mmol/l for *Yankasa* rams (Dangut, 2016), 1.01 to 1.54mg/dl for *Yankasa* rams (Girgiri, 2017), 42mmol/l and 68mmol/l for *Yankasa* and *Ouda* rams respectively (Njidda *et al.*, 2014). A range of 1 to 2.7mg/dl (Marck manual, 2016), 1.21 to 1.44mg/dl by Aruwayo *et al.* (2011) and 0.9 to 2.0mg/dl (Plumb, 1999) were higher than the values of the current study. Elevated creatinine levels may indicate renal dysfunction hence, the rams in this study were within the normal range and are well and healthy.

Serum glucose is a biochemical parameter used as an indicator of carbohydrate metabolism in high energy diets (Jain, 1993). When glucose is lower than the normal range it is an indication of hypoglycemia, while higher level is a sign of hyperglycemia (Olorunmisomo *et al.*, 2012). The glucose obtained in the current study was significantly different among the animals before feeding and not varied four hours after feeding with a respective range of 2 to 3.2mmol/l and 3.5 to 4.05mmol/l. The result of this study falls within the recommended range of 1.7 to 3.6mmol/l (Peter and Peter, 2002), although the values recorded at four hours after feeding were a bit higher than the recommended levels. Similar values were recorded for *Balami* (2.2 to 2.4mmol/l), *Ouda* (2.78 to 3mmol/l) and *Yankasa* sheep (3mmol/l) by Njidda *et al.* (2014). Nonetheless, Girgiri (2017) got a higher values ranged from 17.41 to 41.5mmol/l for *Yankasa* rams and Dangut (2016) reported a range of 53.30 to 56.05mmol/l for *Yankasa* rams fed acha straw diet with protein:energy supplements.

The blood albumin values obtained in the current study ranged from 28.50 to 36.50g/dl before feeding and 26.50 to 37.00g/dl four hours after feeding. Some of the values verified in this study falls within the range of 24 to 30g/l while other were slightly above the reference values of Peter and Peter (2002). The current result was in comparable with the results of Njidda *et al.* (2014) who recorded 28 to 30g/l for *Balami*, 27 to 29g/l for *Ouda* and 26 to 32g/l for *Yankasa* sheep. However, lower values of 2.90 to 3.35g/dl were obtained by Girgiri (2017), 2.64 to 3.00g/dl as normal range values for sheep according to Merck manual (2016) and 2.77 to 3.17g/dl (Aruwayo *et al.*, 2011). Based on the values recorded in this work, it implies that the feeds used had no adverse or negative effects on blood albumin of *Balami* rams and the variation among the groups is as a result of the different varieties of HSF which differs in their nutrient composition.

The range values of total and conjugated bilirubin in this study were 1.45 to 2.00mmol/l and 3.30 to 4.55mmol/l with no difference between the treatments before feeding as well as 0.90



to 1.80mmol/l and 2.20 to 4.40mmol/l four hours after feeding. The values agreed with the findings of Peter and Peter (2002) who reported a range values of 1.71 to 8.55mmol/l for total bilirubin and 0 to 4.61 for conjugated bilirubin. Higher levels of both total and conjugated bilirubin may indicate impaired liver function or haemolytic crisis where RBC is being destroyed too quickly (Jain, 1993).

The serum glutamic oxaloacetic transaminase (SGOT or ASAT) and serum glutamic pyruvic transaminase (SGPT or ALAT) are excellent markers of liver damage caused by exposure to toxic substances (Ranjhan, 1999). SGOT or ASAT level is helpful for the diagnosis and following of cases of myocardial infarction, hepatocellular disease and skeletal muscle disorders. The values obtained for SGOT or ASAT in the current study were 91 to 104.5mmol/l before feeding and 52 to 109iu/l four hours after feeding. All the values were within the reference range of 60 to 280 reported by Peter and Peter (2002) except treatment 4 (52iu/l) after feeding. The values were comparable with 14 to 123mmol/l as normal range for sheep (Jain, 1993) and analogous to range of 36 to 119.35mmol/l for Yankasa rams (Girgiri, 2017), 110mmol/l for *Yankasa* ewe, 126iu/l for Ouda rams and 143iu/l for *Ouda* ewe reported by Njidda *et al.* (2014). However, lower range of 20 to 24iu/l were recorded for *Balami* sheep and 47mmol/l for Yankasa rams (Njidda *et al.*, 2014). The SGPT or ALAT in this study ranged from 13 to 18.5mmol/l before feeding and 13 to 16.55mmol/l four hours after feeding with significant difference and non-difference across the groups in respect of before and after feeding. All the values observed were within the recommended range of 22 to 33mmol/l reported by Peter and Peter (2002), 15 to 44mmol/l (Jain, 1993) and 22iu/l for Yankasa rams (Njidda *et al.*, 2014). Nonetheless, the values of the present study were higher than 8iu/l for *Balami* rams and 9mmol/l for *Balami* ewe but lower than 44iu/l for Yankasa ewe, 39mmol/l for Ouda rams and 45iu/l for Ouda ewe (Njidda *et al.*, 2014). and ranged values of 29.5 to 50mmol/l for Yankasa rams (Girgiri, 2017). The results of this study indicates that the experimental feed were not toxic to the liver of the animals.

The blood cholesterol observed in this study were within the range of 1.95 to 2.50mmol/l before feeding and 1.66 to 2.30mmol/l four hours after feeding. This values were a little higher than the range of 1.05 to 1.50mmol/l reported by Peter and Peter (2002), though is not up to the detrimental 5% level. Nevertheless, the values recorded were in conformity with the results obtained by Njidda *et al.* (2014) for *Balami* (1.8 to 2mmol/l), *Ouda* (2.3 to 2.5mmol/l) and *Yankasa* (1.9mmol/l) rams. However, higher value was recorded (3.5mmol/l) for *Yankasa* ewes.

The alkaline phosphatase observed in treatment 1 and 2 were within the recommended range of 70 to 390iu/l. However, lower values were recorded in treatment 3 (30.5iu/l after feeding and 56.5iu/l before feeding) and treatment 4 (52iu/l after feeding and 77.5iu/l before feeding) which were in disparity with the result (105 to 305iu/l) of Njidda *et al.* (2014) for *Balami* sheep. Notwithstanding, he further reported a similar value of 29 to 55iu/l for *Yankasa* and 42 to 65iu/l for *Ouda* sheep.

## CONCLUSION AND RECOMMENDATION

The haemato-biochemical indices obtained in this study were within the recommended levels for a healthy sheep. However, values recorded four hours after feeding indicated significant ( $P < 0.05$ ) difference among the treatment with T4 (*Jigari* variety) having the superior values for most of the parameters. Therefore, this indicates that the proportion of nutrient in the basal and supplement diets were efficient in all the varieties for normal physiological function of *Balami* rams with rams fed *Jigari* variety of hydroponic sorghum fodder performed excellently and is highly recommended.

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